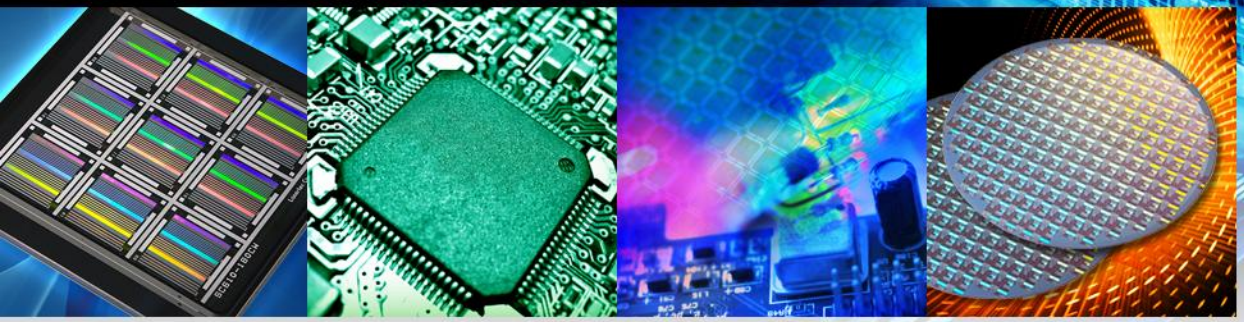
Lasertec

EUVL symposium 2014



Defect inspection and characterization on actinic blank inspection tool

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Lasertec EIDEC

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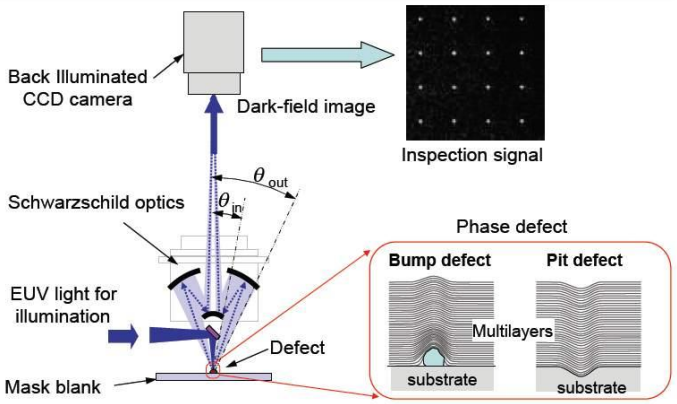
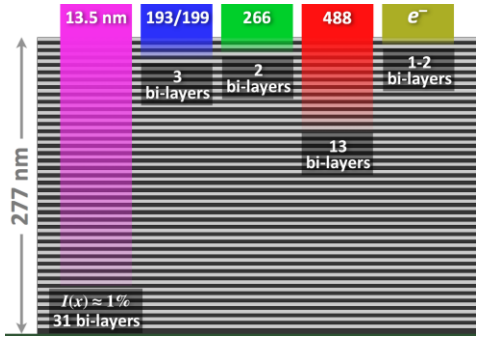
ABI tool development status

Dark field inspection

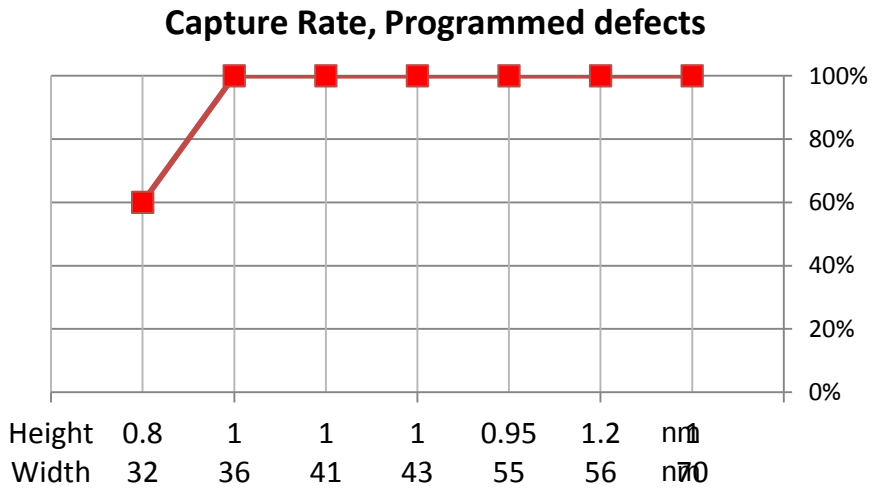


Tsuneo Terasawa et al., Development of actinic full-field EUV mask blank inspection tool at MIRAI-Selete, Proc. of SPIE vol. 7271 (2009)

Actinic inspection

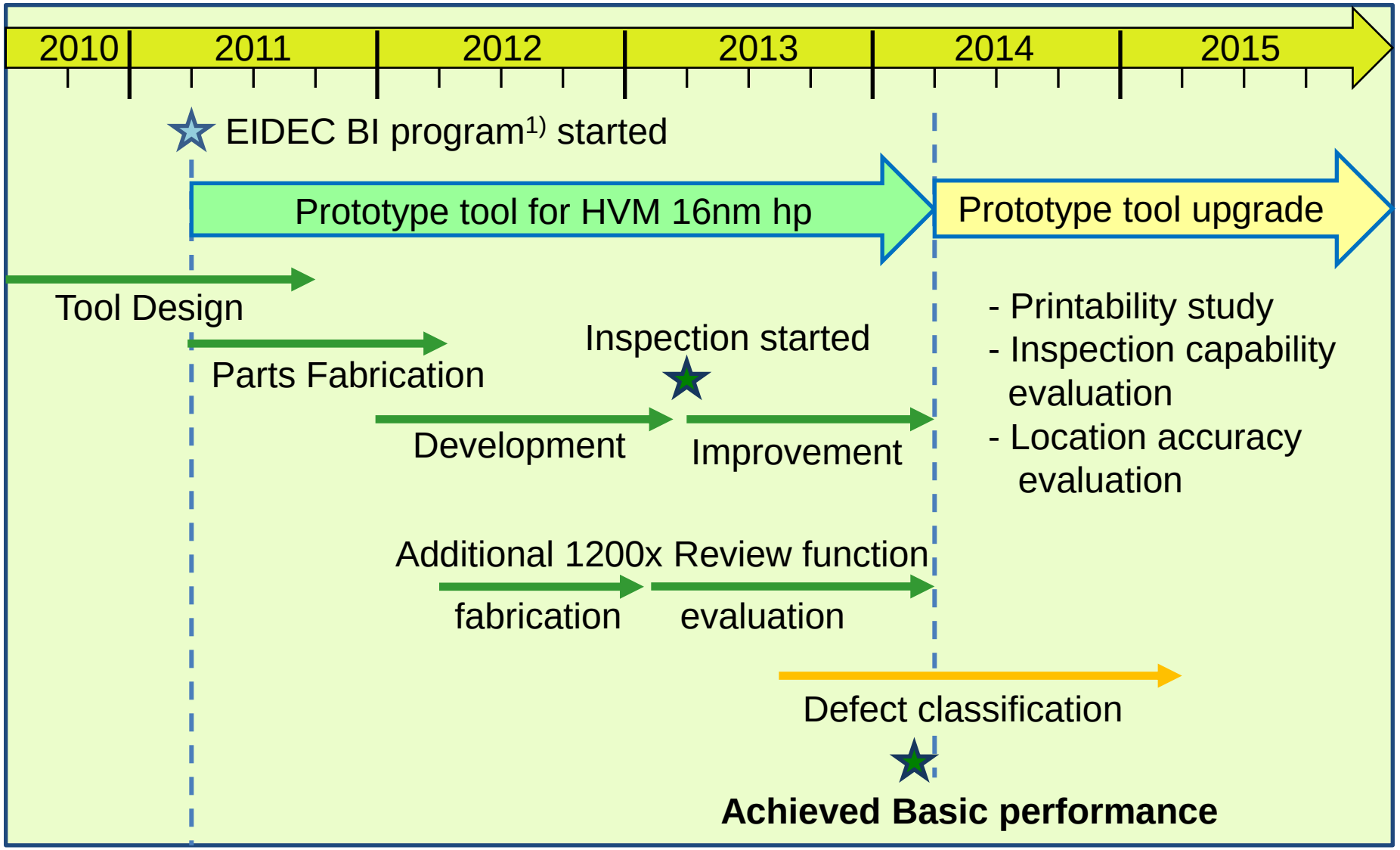


K. Goldberg et al., "Defect detection and inspection unmasked", IWEUVL, 2010



ABI HVM Tool is ready to play an important role in phase defect control

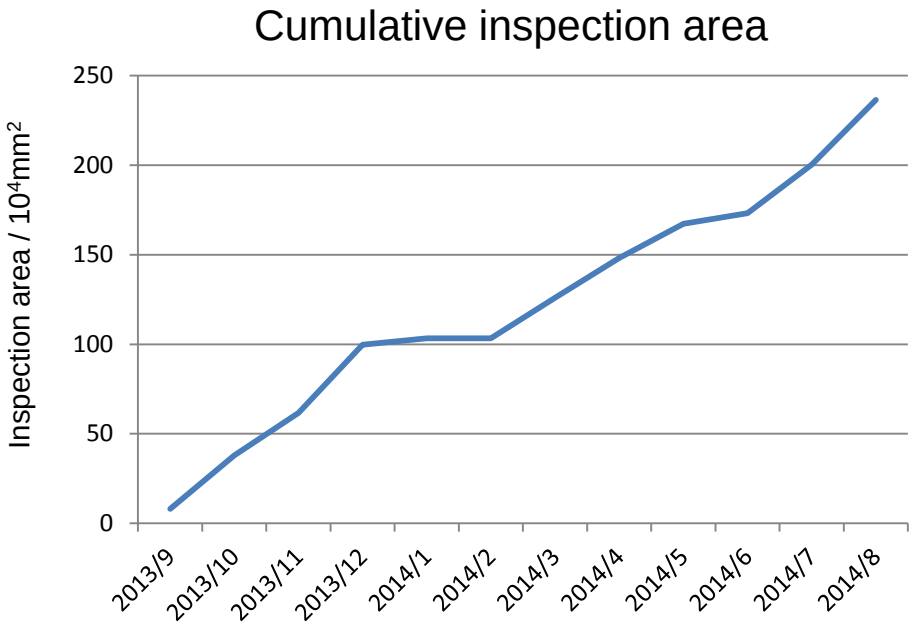
EIDEC/Lasertec BI Program Schedule



1) BI Program: Blank Inspection program

ABI tool – inspection performance

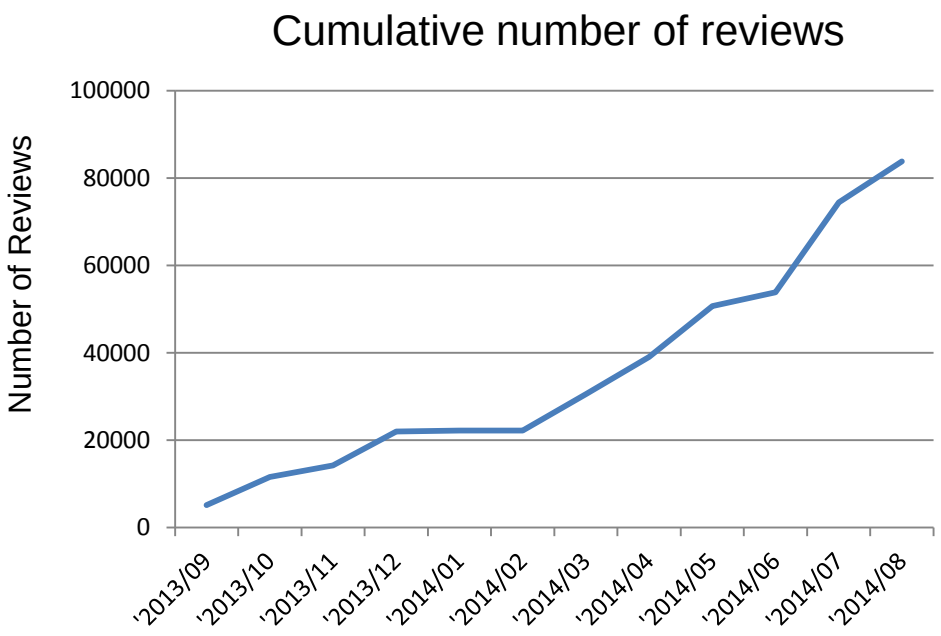
- The ABI tool inspected more than 200 x10^4mm^2 in one year.
- Signal intensity has been stable during this period.
- The ABI tool meets the 16nm-sensitivity requirement and is currently being used for actual EUV mask blanks inspection.



The ABI tool has demonstrated its actinic inspection performance through a year of operation.

ABI tool - review function

- Actinic review is available for all defects detected by the ABI tool.
- The ABI tool performed more than 80,000 reviews in one year.



Actinic review function is crucial for understanding defect characteristics

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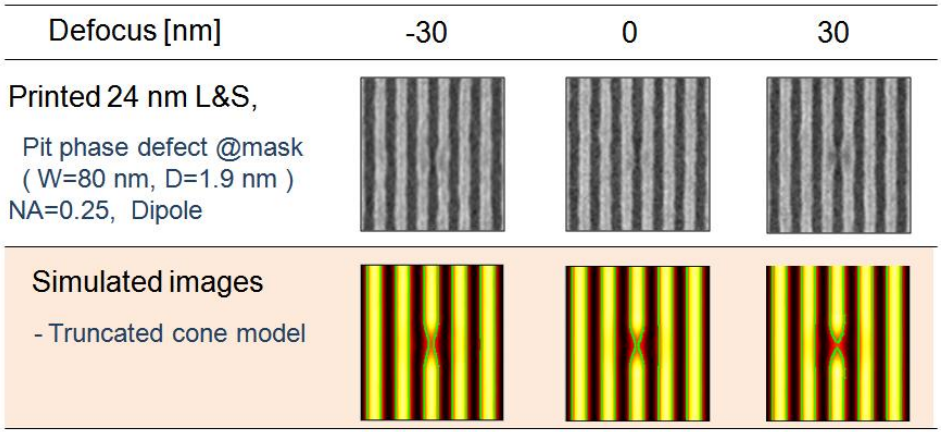
Previous studies on printability of phase defect

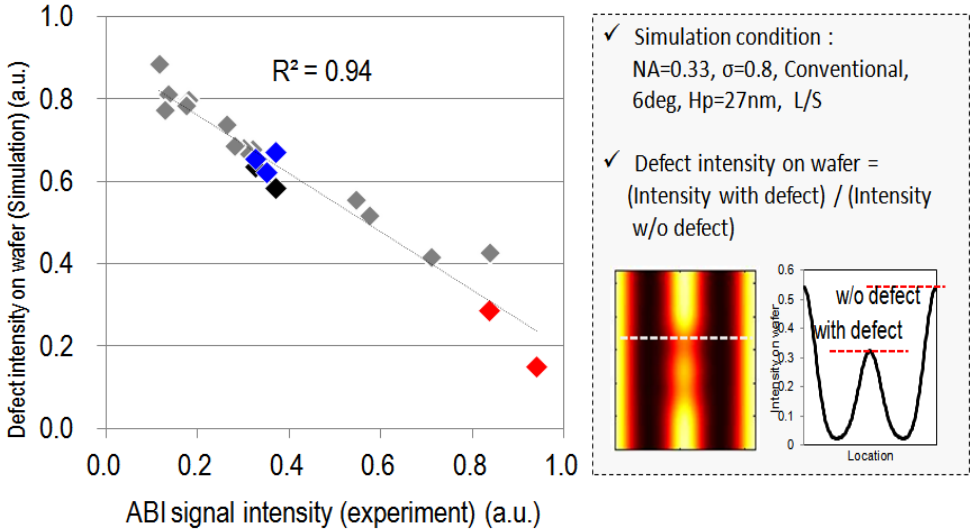
Relation between Printability simulation and experiment



Tsuneo Terasawa et al., EIDEC symposium 2013

Simulation on bridge defect on wafer matched the experiment result.

Simulation study for Wafer impact as a function of ABI intensity

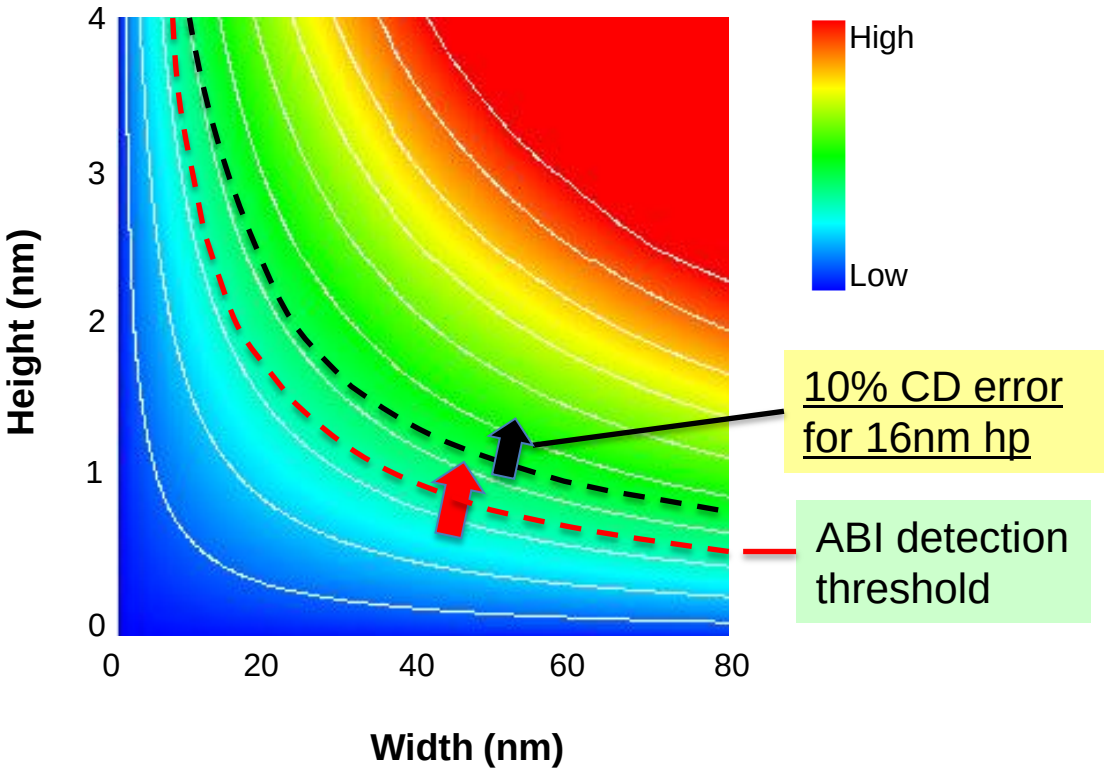


Noriaki Takagi et al., EIDEC symposium 2013

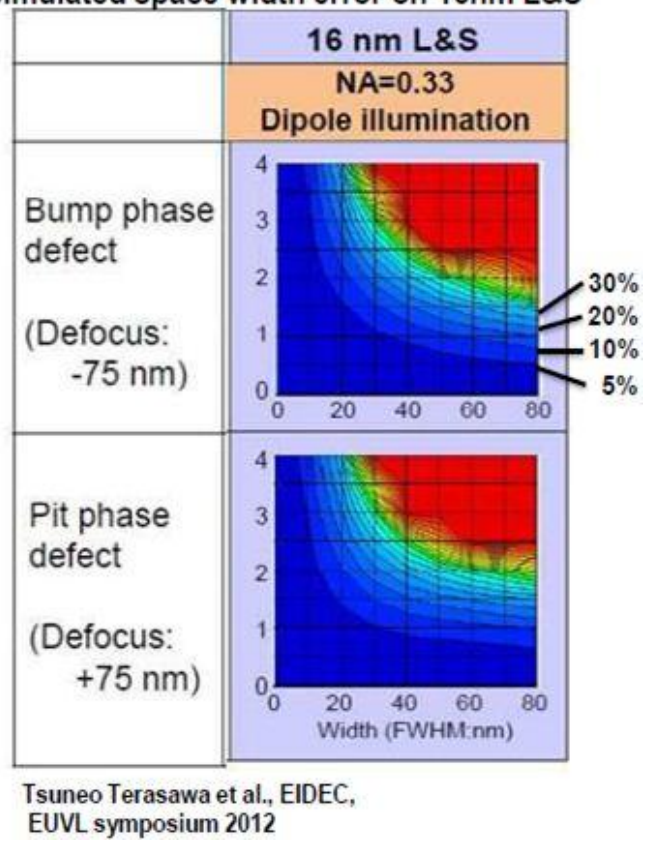
Simulation shows ABI signal intensity proportionally co-related to defect intensity on wafer.

Printing impact from ABI signal intensity

Experimental ABI signal intensity
as a function of phase defect size



Simulated space width error on 16nm L&S



Tsuneo Terasawa et al., EIDEC,
EUVL symposium 2012

ABI signal intensity represents wafer printing impact

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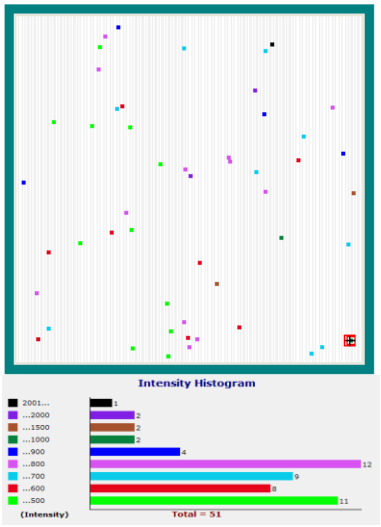
Defect characterization – ABI flow

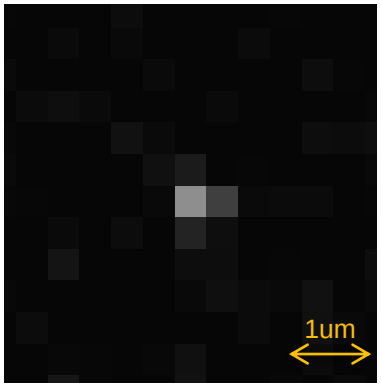
Defect Inspection

Low Magnification Review

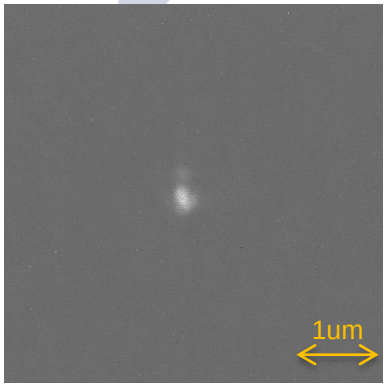
High Magnification Review



Review of each defect



high resolution

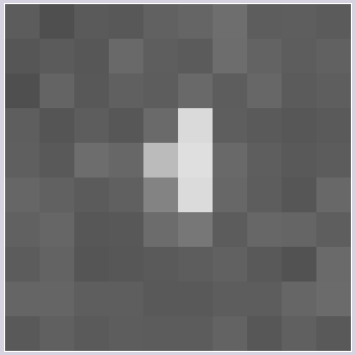
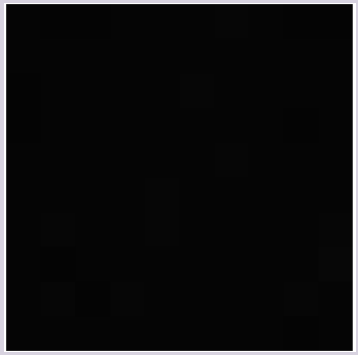
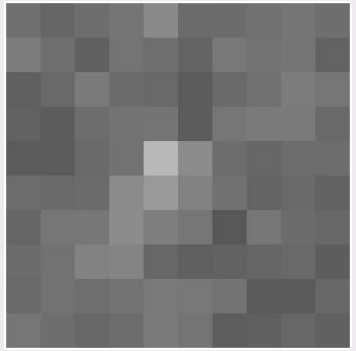
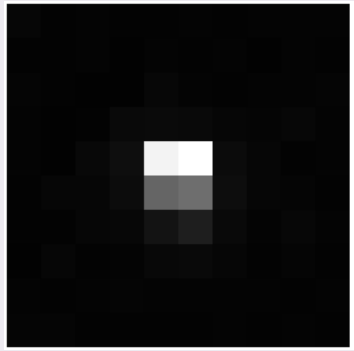


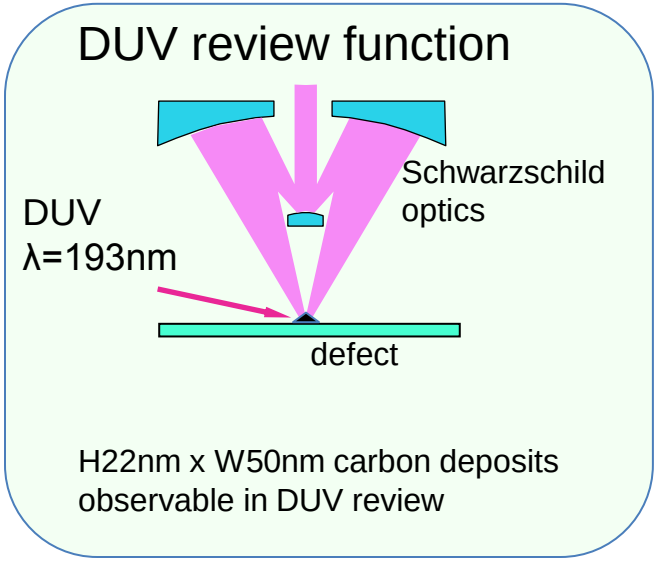
-Defect map with DSI (defect signal intensity)

-False elimination
-Phase / Amplitude defect classification

-Pit/Bump classification
-Measurement of defect location and size

Phase / Amplitude defect classification

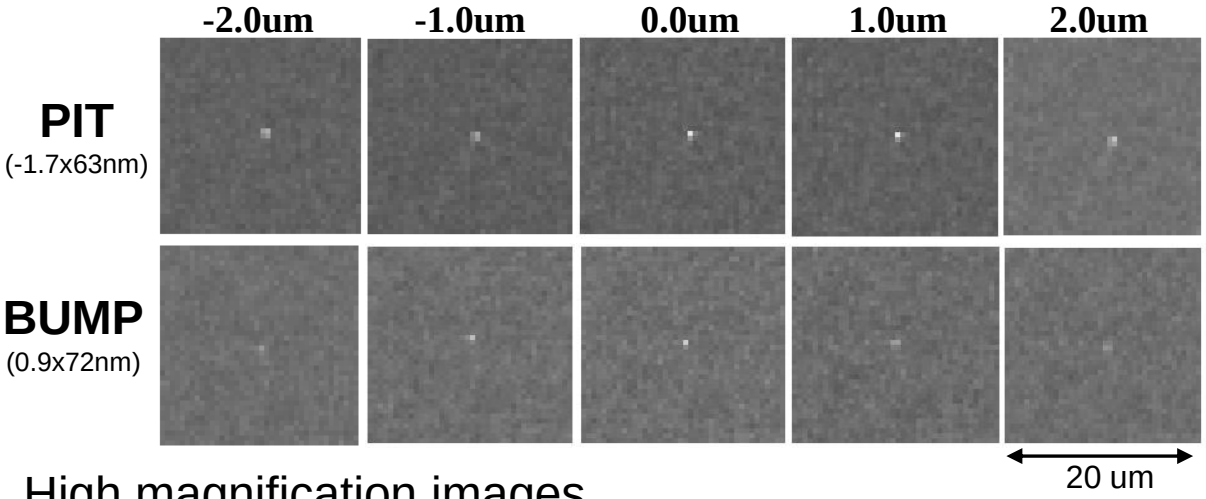
Defect type	EUV review	DUV review
Phase Defect (H2.4nm, W200nm)		
Amplitude Defect (H50nm, W76nm)		



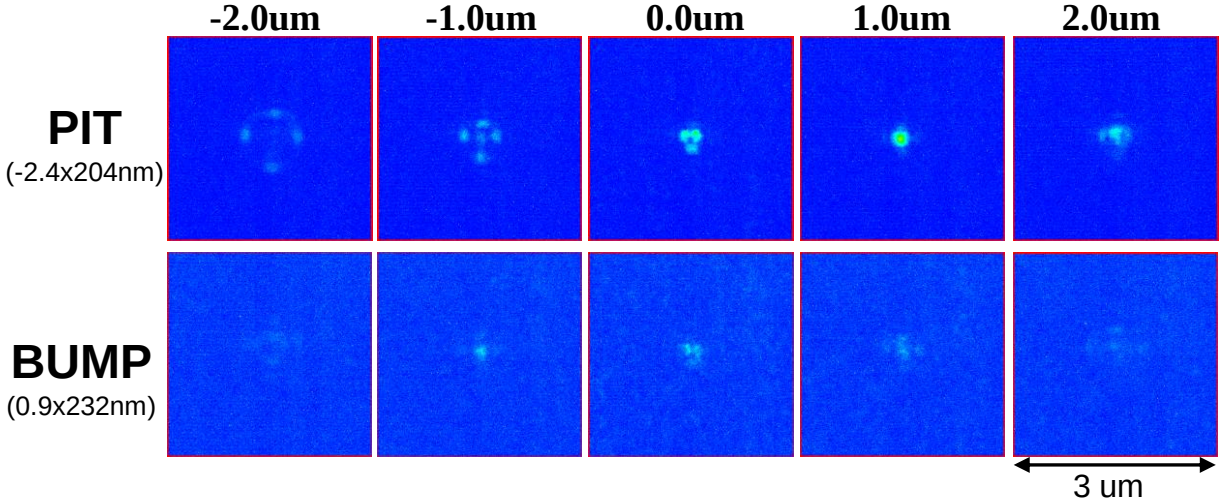
With EUV and DUV reviews, Phase/Amplitude can be distinguished.

Pit and Bump - Through focus images

Low magnification images



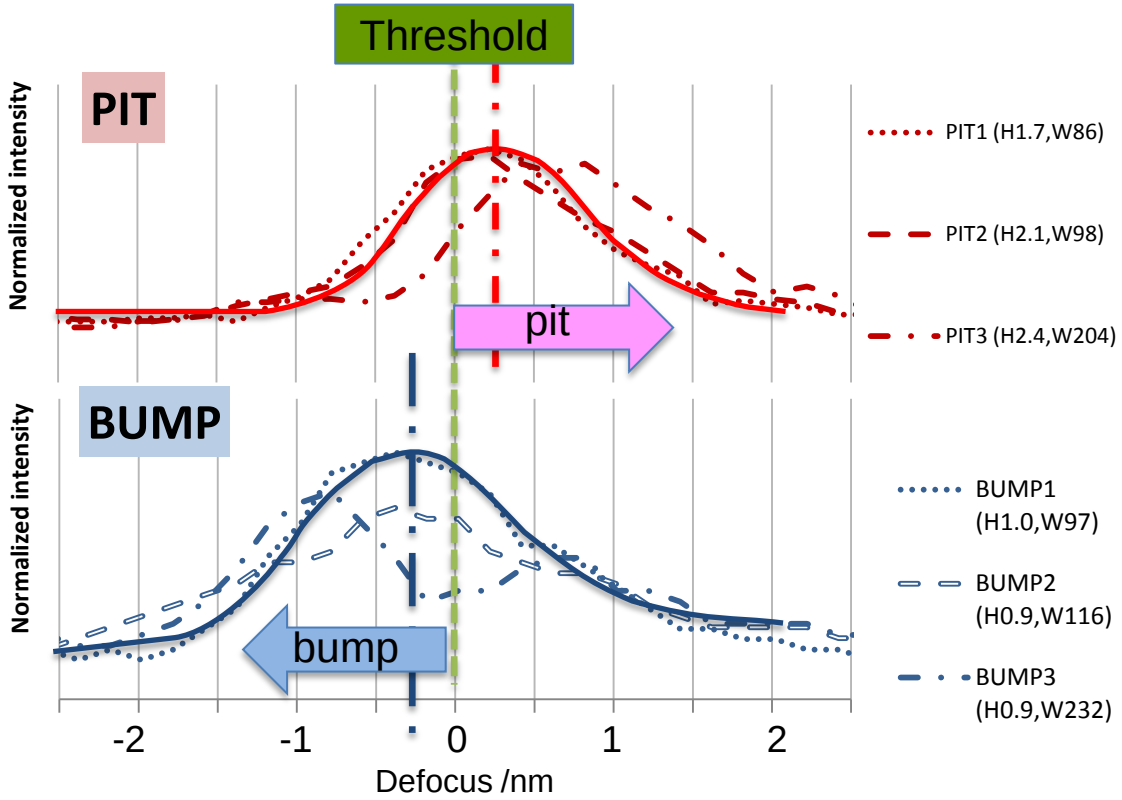
High magnification images



The position where the image focuses differs, depending on whether the defect is pit or bump.

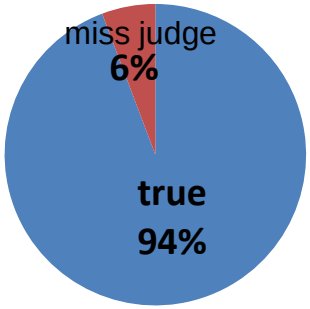
Pit / Bump classification function

Through focus image analysis for pit/bump classification



Focus dependent intensity profiles for programmed phase defects

Pit / Bump classification result



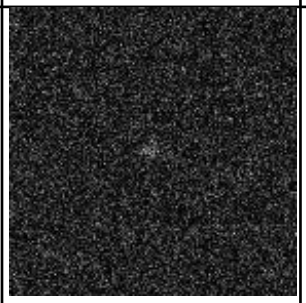
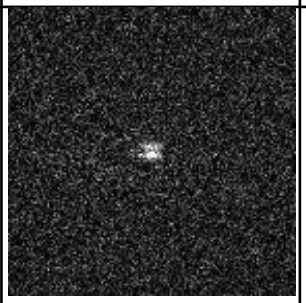
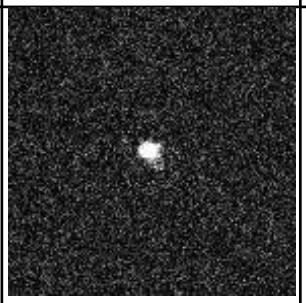
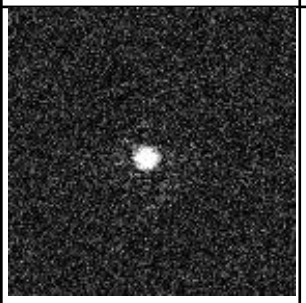
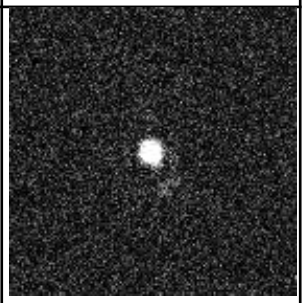
judged form >100 samples of programmed defect and native defect

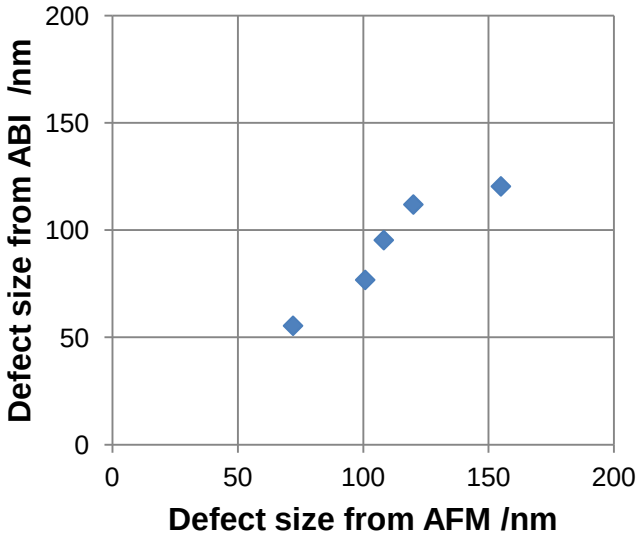
Details of focus dependency, see reference poster session “The influence of phase defect characteristics on scattered light images in actinic dark field inspection” Noriaki Takagi, EIDEC

With through focus image analysis, Pit/Bump classification is possible.

Defect size measurement

Programmed phase defect images from high magnification optics

Defect width by AFM	**72nm**	**101nm**	**108nm**	**120nm**	**154nm**
Defect images by high Mag. review					
Defect Diameter from ABI images	55nm	76nm	95nm	112nm	120nm



With ABI high magnification review images, defect size measurement is possible.

Comparison of measurement results from ABI review and AFM

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Summary

1. The ABI HVM prototype performs EUV blank inspection and review to assist the efforts to develop better EUV blanks.

2. ABI review images facilitate the following defect characterization, which contributes to EUV blank defect management.
   - Phase/Amplitude classification
   - Pit/Bump classification
   - Defect size measurement

Acknowledgements

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Thank you very much for your attention.

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